Offshoring R&D

The relationship between transparency, communication structures and knowledge

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Published in:
Proceedings for R&D Management conference

Publication date:
2010

Offshoring R&D: The relationship between transparency, communication structures and knowledge

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Companies are increasingly offshoring R&D activities. Many firms, however, experience difficulties related to virtual teamwork across cultures and time zones. The research question is: *How does increasing R&D offshoring impact transparency of communication structures and knowledge sharing?* Using case studies from Danish multinational corporations with R&D activities in China, India or Eastern Europe this paper analyses the impact observed in these companies in regard to communication structures and knowledge sharing in management of offshored R&D activities. The findings show that companies attempt to increase transparency through formalisation of knowledge and clear communication structures. However, the influence of tacit knowledge, horizontal communication and culture seem largely overlooked. Therefore the authors suggest a context based approach to transparency accustomed to the complexity of the R&D activity. This paper shows that management of offshored R&D activities touches upon many key management dilemmas like trust, control and knowledge sharing.

1. Introduction

Advances in technology (e.g. the internet, telecommunication) and political shifts (e.g. the collapse of the Soviet Union, fewer trade barriers and an enlarged EU) have lead to increased global competition and new markets. This has enabled the rapid growth of companies offshoring various business activities including research and development (R&D).

This paper employs the definition that offshoring occurs when "...firms relocate their business functions (that were previously performed inhouse) to overseas locations." (Kedia et al., 2009: 250).

This can be achieved in one of three ways:

1. Green field.
2. Brown field.
3. Buy up/consolidation (Colotla, 2003).

The green field approach is when the company builds their own factory or office; the second when the company expands their current locations; and the last happens during mergers and acquisitions. Traditionally, companies first offshored production, and only later offshored tasks and functions further into the development process, from design to R&D. This creates an environment of cross-cultural virtual communication and knowledge sharing in R&D activities, which spans cultures, national borders, and time zones.

Knowledge and information creation, sharing and retention now have to span this virtual space. This has meant management of R&D are faced with new challenges. This can mean a loss of transparency as not all employees have the same information and the same understanding. It can also become unclear to headquarters about what each offshore location is doing, and for the subsidiary to fail to understand the reasons behind information and actions taken headquarters.

This paper examines management of offshore R&D in relation to transparency. The research question is:

How does increasing R&D offshoring impact transparency of communication structures and knowledge sharing?

The data is based upon case studies of four Danish

multinational corporations involving many semi-structured interviews. The article first presents a literature review on the topics of transparency, communication, and knowledge transfer relevant for management of offshored activities. The empirical method is then discussed, followed by an explanation of the data collection method with detailed findings. A conclusion and further research is presented in the final section.

2. Literature review

Offshoring is an important part of companies' internationalisation efforts (Hemmert, 2004). Despite the focus in recent years on learning and knowledge in internationalisation, few case studies have been carried out concerning organisational learning processes in the internationally developing firm (Lord and Ranft, 2000; Andersen, 2008).

Andersen (2008) investigated learning processes in offshoring by two multinational Danish companies. His findings showed that:

1) Routines play a role in guiding the initial international activities of companies accessing new countries; especially for experienced companies which have developed more routines.
2) Organisational knowledge is vested in routines, which resist change. The persistence of existing organisational routines influences the learning abilities of organisations.
3) The speed and scope by which organisations learn to cope with increasingly foreign market conditions is critically contingent on their ability to modify or discard existing mental models; i.e. to unlearn. Unlearning processes concerns routines that have grown obsolete and are discarded (Sinkula, 2002).

Knowledge management has been defined in many ways but generally refers to how companies create, retain, and share knowledge (Argote, 1999; Huber 1991). This includes the procedures and techniques used to get the most from an organisation's tacit and codified knowledge (Teece, 2000).

Knowledge can be separated into two main categories; explicit or tacit.

- Explicit knowledge can be documented, categorised, codified, transmitted to others as information, and illustrated through demonstrations, explanations and other forms of sharing.
- Tacit knowledge, also called personal knowledge or 'know how', draws on the experience and learning of a person and includes habits and skills we do not always recognize as knowledge. It's hard to document and keep in the company, and often has a social and cultural element (Polanyi, 1966; Nonaka & Takeuchi, 1995; Castells, 1996: 171-172; Debowski, 2006: 347, 353, Hansen et al., 1999).

Some authorities also include implicit knowledge (Wallace et al., 2004). Implicit knowledge is knowledge which "…cannot easily be articulated by the person possessing it, but can be elicited and articulated by others. An example of implicit knowledge is the strategy adopted by an experienced designer to undertake a particular task in the design process." (Ahmed *et al*., 2005:1-2).

Explicit knowledge can be said to create an organisational memory for the organisation. It has three main functions, to:

1) Control what information is valuable enough to store and share with the organisation.
2) Prioritize the information so only the most valuable is stored.
3) Prevent information overload (Walsh and Ungson, 1991).

Knowledge can be transformed from one type of knowledge to another.

Knowledge creation can be viewed as an activity which focuses on collaboration and accomplishing certain tasks (Nonaka et al., 1995). A company which offshores can need to transfer knowledge between several units in the corporation; the headquarters, sales offices, subsidiaries, supplies, customers etc. In (Nonaka *et al*., 2002) a model is proposed which states that new knowledge is created and transformed through a cycle of social interaction between these knowledge types through socialization, externalization, combination and internalization (see Fig. 1).

This model is called the SECI knowledge model and is based on the separation of tacit and explicit knowledge.

Source: Boutellier et al., (1993: 2-11).

Figure 1. SECI knowledge model. From (Nonaka *et al*., 2002)

As figure 1 shows, knowledge generation and transformation can be illustrated as a circle with a spiral inside, in which explicit and tacit knowledge is connected, meaning that knowledge of one kind can be transformed into another kind. Knowledge transformation goes from individual to individual, individual to group, group to organisation, organisation to individual and then begins over again (Bleischwitz *et al*., 2004: 354). The following details each of these examples of knowledge sharing:

- Socialization - individual to individual

The sharing of tacit knowledge through face-to-face communication, or shared experience and shared understanding. An example is an apprenticeship.

- Externalization individual to group

Communication and reflection of tacit knowledge through development of explicit concepts. In this way knowledge can be expressed through various

forms of communication (also music and visual art). For example, through unofficial and official meetings, or perhaps as an option to show the group through for example shadowing, where the group sees how the other person works by observing them in their daily routines.

- Combination– group to organisation

The combination of various elements of explicit knowledge. In this phase the concepts are systemised in a knowledge system, which integrates different kinds of explicit knowledge. In this manner tacit knowledge becomes accessible and understandable for all. Through these combination processes adjustments, reorganisation and (re)combinations can be created which can foster new knowledge. Examples are policies for saving and documenting knowledge and putting it to use in the organisation.

- Internalization – organisation to individual

The knowledge becomes part of the individual's knowledge base (e.g. mental models) and can then also be accessible to the organisation. From here new knowledge can be created and the process starts all over (the circle arrow on the figure). Examples are work policies loose enough to allow the individual to find a better way of conducting a given task.

Virtual collaboration will often be missing the 'socialization' step; but for the multinational corporation to function optimally the knowledge transformation still needs to take place. Rasmussen & Wangel (2007) show that three main areas need to function for a virtual team to be successful; trust, identity, and knowledge sharing.

Identity is connected to sharing a feeling of belonging. Trust can be defined in many ways. The one used here is developed by Rotter (1971) who defines trust as a generalized tendency to assume that others will fulfil the expectations one has of them. Complete transparency can be defined as "complete information versus incomplete information" (Kanagaretnam *et al*, 2010). Key findings in a study Kanagaretnam *et al* (2010) show that 1) transparency (complete information) significantly increases trusting behaviour. This result persisted in repeated interactions. 2) Transparency appears important for trustworthiness in one-shot interactions. And 3) repeated interaction increases trust and reciprocity with or without transparency. These results suggest that transparency is important in building trust in business environments which requires collaboration between different entities which have not previously worked together (see for example Knowles, 2006). Transparency is important when a company has just started to work virtually.

Even when a common identity is created and trust has been developed, knowledge sharing remains key ''... knowledge transfer in dispersed teams is not an effortless integration of global diversity transmitted through digital networks, but involves often arduous, recursive work patterns with regular breakdowns in knowledge exchange'' (Sapsed *et al*. 2003: 22). Organisational culture is "The shared rules governing cognitive and affective aspects of membership in an organisation and the means whereby they are shaped and expressed" (Alveson 2002: 3).

Communication in a global organisation needs to consider the influence differences in subcultures at different locations in the global corporation, and national culture have on communication itself. According to Hall (1976: 91) two types of communication cultures exist; low-context and high-context communication, "...A high-context (HC) communication or message is one in which most of the information is either in the physical context or internalised in the person, while very little is in the coded, explicit, transmitted part of the message. A low-context (LC) communication is just the opposite, i.e. the mass of the information is vested in the explicit code."

This review indicates that several elements are important for successful offshore management, among others culture, trust and knowledge sharing. To achieve this, transparency as a mediating factor is a key issue.

3. Empirical method

The nature of the research questions suggested a case study approach due to their explorative nature of an area wherein unknown factors and elements are sought (Yin, 1994). Multiple case studies were used to be able to make comparisons and to distance the researcher (Eisenhardt, 1988). For consistency, all companies were large international corporations with headquarters and ownership in Denmark.

Table 1 illustrates the case companies with regard to type of company, company work form, the position of the interviewees, and the number of interviewees. The cases were selected to get breadth in the dataset across sectors and sizes.

Company[1]	Type	Work form	Positions	Amount
X1	B2B and B2C telecommunication manufacturer	Product based	Vice presidents, managers	3
X2	B2B equipment and service to the raw materials sector	Project based	Vice presidents, managers	11
X3	B2B engineering consultancy	Project based	Managers	12
X4	B2B service and equipment provider to the energy sector	Project based	Managers	3

Table 1. Cases and interviewee details.

[1] All case companies are given synonyms to respect their wishes for anonymity.

Interviews were conducted with managers and vice presidents who managed different aspects of offshored R&D, both in the headquarters and in the subsidiaries. By interviewing employees in both corporate headquarters and at the subsidiaries a multifaceted perspective is gained. Vice presidents have insight into the decision process and justification surrounding offshoring, and can present another perspective to the managers - who were responsible for implementation and the daily management - on the research topic.
The primary data source was semi-structured interviews; so structured questions were asked but the interview was open for new information. There was little or no documentation available in the companies on the research topic, which meant the interviews were the primary data source.
The questions were related to issues seen as causing complexity, which tools were used to reach greater transparency and the observed implications of this – all of these issues seen in relation to its impact on knowledge transformation. Not all interviewees were asked all the questions as some questions were only relevant for certain groups. All the interviews lasted 50-70 minutes, and were audio recorded, transcribed and analysed.

4. Findings

Table 2 shows the details of the case companies. The target countries were mainly China and India; the two companies with R&D in USA were due to a buy-up many years earlier and the unit served mainly the American market.
All of the case companies had embarked on offshoring as a 'learning by doing' process. There had been no clear strategy or details on how the relationship between the now offshored parts of R&D should be connected to the parts of R&D which remained at the headquarters. Communication details were also developed as the R&D assignments were moved, and followed standard virtual networking which the companies had used when they had offshored other elements of their product development process like production and basic design tasks.

Company synonym	**R&D abroad**	**Countries with main offshore R and/or D activities**	**Use of expats at offshore R&D location**	**Future plans for R&D**
X1	Some D in China for Danish projects	China	No	Move more D abroad
X2	70% of D is in India, some R is being moved now to India too with the expectation to have ca. 15% of R in India within the year	India and the USA	Only director of the facility in India	Move more R&D abroad
X3	D in USA for US projects D in China for local projects Some D in China for Danish projects	China and the USA	Yes; as experts and project leaders	Move more D abroad
X4	Some D in China for local as well as global projects	China	Yes; as experts and project leaders	Move more D abroad

Table 2. Characteristics of the cases.

Most of the case companies went through the same process when offshoring; if the company had production then it was offshored first and then the other phases followed, effectively going backwards in the development process. Only X2 wanted to offshore their research process as well as the development process; the others felt the key competences were at the headquarters so there was no gain by moving research abroad.
X1 first offshored all of production, parts of production ramp-up, testing and refinement, detailed design, then outsourced all of embedded IT, offshored parts of the system level design and finally outsourced all of production.
X2 outsourced all production from Denmark during a costcutting restructuring period from 2000-2004, first to Eastern Europe and then to China. In the 1990s, X2 had brought a company which had a subsidiary in India. Over the years this office grew, and slowly, as competencies were transferred, it received more knowledge-intense assignments. The Indian office now does most of the system level design, and all subsequent phases up to production for all standardized products.
X3 created an office in China to serve the market there. Later design for foreign projects also draws on resources from this location. X4 followed the same path as X3.
The following sections present results relating to:

1. The impact offshored R&D has on communication structures and knowledge sharing.

2. How multinationals try to enhance transparency for offshored R&D activities.
3. The relationship between transparency, communication and knowledge.

4.1 Impact of offshored R&D activities on communication and knowledge

The case companies showed that offshored R&D activities presented several challenges for management. These were related to culture and information sharing and understanding.

1) Culture

Culture was an element all the case companies saw as an obstacle, and it influenced all other difficulties. It was visible in how information was communicated, what information was communicated, how information was understood and how the work was approached.

The Danish interviewees felt their colleagues in India and China rarely wanted to deliver negative information, and that the employees in these countries found it difficult to ask questions.

A manager from X2 explained it like this; "*The Danish way is very simplistic but the Indians they blow small things up to huge achievements and everything is fantastic*." A manager from X1 added that, "*[A positive thing about how] very different the culture is, is that the whole culture is 'get around'. So when you see a problem and you can't solve it, you just get around it. So they don't find the root cause and they are not very good at that, but they solve the problem in some way. I mean that often there are goods stuck in Hong Kong transit, then, maybe it's time number 30 that they are stopped in Hong Kong. Still, they just go down and pick up the parcel and come home again. They don't solve the problem, they don't like find an agreement on how not to send it via Hong Kong. They just solve it and that's in many cases very positive, they just find some way and solve it. Just make a get around, that's what they do all the time. It is that it is the same for design of course. They [the Chinese colleagues] can make much more simple setups.*"

However, this simplicity can also be an obstacle if the goal is innovation and efficiency in the development process. Many of the Danish managers quickly got the feeling that their Indian or Chinese colleagues needed much more 'hand holding' and 'mentoring', as they asked for confirmation to a larger degree than the Danish engineers. However, they were much better at following directions, procedures, and processes.

Where Danish engineers would be likely to debate the usefulness, efficiency and correctness of such codified tools, the foreign engineers would follow them as precisely as possible.

2) Communication structures

Virtual communication was seen as being difficult due to time zone differences and culture which meant differences in how information was delivered, to whom and how information was received and understood.

A manager from X4 illustrated this; "*... the written communication can be difficult with all these details and misunderstandings can easily occur. And then if their English is different from our English it can also be a challenge*."

A manager from X2, explained the issue with virtual communication as follows, "*It is very difficult to start something very big and very new when you're talking to this guy and he's talking to this guy and so on. It's too fragmented. The timing makes it hard for somebody to get a question from one group to the other [because they aren't all in the same video conference at the same time]. We can't be sure we get this question from one group to the other. So, it is like being an interpreter who translates from one to the other.*"

Coordination between subsidiaries and the headquarters and between the subsidiaries themselves was another challenge. A manager from X4 put it like this; "*Um, the biggest challenge is to keep everybody informed about everything, because all the informal communication will not happen when people are not there*." The vice president of supply chain management at X2 illustrated this when he explained that standards had been developed for the whole multinational for how to approach and contract a supplier. However, many subsidiaries and even departments within the headquarters didn't know about this.

Ensuring all had the same information and that it was up to date, followed and understood it the same way, was another area creating difficulties. A manager from X2 explained the issue with information as follows, "*The guy who is fronting this [in our Indian office], this is a bright guy. So they are clever guys but the guys down here [the lower level engineers] are sometimes of another breed so we don't know how the [information flow is] ...*"

All the case companies had similar information flows; the example of case company X4 is shown here to illustrate. The information flow at X2 is shown in figure 3; managers speak to managers and at times the top managers speak with the top managers in India but at the operational level interaction is seldom. Vertical communication happens isolated in each location, without the other locations having knowledge of the details concerning this.

While the managers at the Indian site in theory could also facilitate contact, they rarely did this unless something very urgent came up. Communication was mainly initiated by the Danish headquarters and was mainly related to (1) division of new tasks and (2) checking up on and status reports for current projects.

Checking was often done at least once a week at different levels of detail depending on how complex and valuable the offshored task is perceived by the headquarters to be. The communication and information initiatives, procedures and processes were created in and by the Danish headquarters.

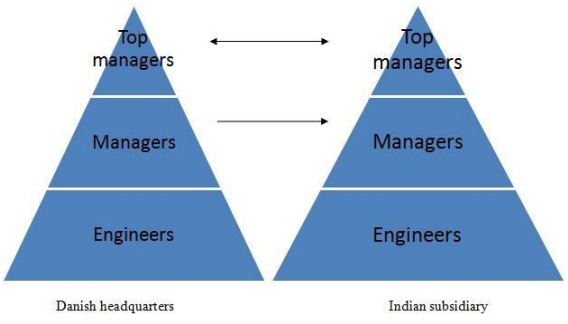

Figure 2: Information flow in case company X2

While the contact manager in India would understand the rules and assignments given, it was unknown to the Danish headquarters how the further communication channels in the Indian subsidiary were. As a result the product they got back could contain mistakes that the Danish headquarters had thought had already been resolved. The same was the case in the communication with the US R&D office.

In some of the case companies, for example X3, the expatriates at the subsidiary sometimes made changes and additions to the procedures which came from the headquarters to make them fit better with the work patterns, culture and challenges they experienced in the subsidiary.

To summarise, culture and virtual communication presented difficulties in communication and knowledge sharing for managers responsible for offshored R&D activities.

4.2. Transparency in management of offshored R&D activities

The case companies chose to counteract these difficulties by 1) simplifying the process or product sent abroad for development or 2) making the process more explicit.

In order to handle difficulties with management of offshored R&D activities, the knowledge sharing and communication structures can become more explicit.

The following actions were adopted in the case companies:

1. Detailed documentation, procedures and processes of the task and the process offshored.
2. A clear separation of tasks.
3. One to one communication (manager to manager).

Another way to handle difficulties was to simplify the production process and/or product. For example, some of the case companies offshored a function or task which was technically or technologically complex. To lessen misunderstandings and rework, they lowered the level of complexity in the development process or in the product itself as exemplified in the statement by the manager from X1 in the culture part of the earlier section. This simplification can take place in the development phase by employing known technologies, techniques and methods or in production by utilizing more manpower and less machinery.

Most case companies tried to avoid difficulties with communication structures and knowledge sharing in offshored R&D with a more explicit development process. The interviewees meant that the processes needed to be codified in detail to ensure quality and facilitate clear communication. The reason was to lessen the chance of misunderstandings based on culture as well as the impact of virtual communication.

X1 had an iterative development process of their products. This meant many interactions and communication between the Danish engineers and the R&D engineers in China. This increased the chance of misunderstandings in communication and of information. However, they avoided many difficulties by codifying their processes and using expatriate engineers who acted as liaisons between engineers in China and Denmark. Today the offshore location handles certain product lines from system level design to production. These product lines are the less technically complex lines as technology and educational level has meant X1 has had to simplify some of their processes to make them suitable for offshoring and to keep product changes to a minimum.

X2 had first offshored production and thereafter outsourced a large part of it to reach cost benefits. X2 had chosen to grow their site in India as knowledge and experience with offshoring grew. Besides detailed documentation, X2 also used exchange programs extensively. In order to avoid cultural issues, X2 tried to hire only Indians whom they felt could work in a western business culture. They had also only moved standardized product lines to India so while design was needed it was minor changes carried out within clear specifications. R&D is being moved out during 2010 and requires interaction between R&D in Denmark, USA and India.

A manager from X2 explained their situation;

"You could say we are coming from the situation where we have a lot of senior people in the company who have the knowledge here [in their heads] and knew what to do without many manuals and stuff like this. We are now coming in a situation where these people are outfaced and we have a lot of newcomers in India so we need to put more and more knowledge into systems and manuals and concepts and we are also making configurations and things. One thing is that the communication should be very clear, verbally and written but preferably the written one should be clear because otherwise it will be interpreted in different ways."

X2 had an additional issue affecting coordination with their office in the USA. A manager explained it like this,

"It seems the Danish division has really managed to load India with a lot of things [by offshoring a lot of R&D tasks to the office] where the U.S. office has not managed to do the same. Of course they have not had so many jobs lately and they have not had the same percentage of offshoring that we have seen. They have been very reluctant to offshore anything so to say. They have special rules so the jobs done in the Indian company supporting the US is a bit different for what they did for Denmark and that is one is the things we are trying to avoid now. We say when we now apply the new system, everything is done the same way."

He went on to explain the reluctance the US office had,

"The U.S. has always said that their customers were different from all other countries in the world. That they had other requirements. That they had to select other types of equipment than we would select for the rest of the world and they have different drawings rules as well. These things they said their customers require so they should be like this. We [in Denmark] are not so sure this is correct but we have tried during the years to minimize the fingerprint of these things. We know that there are some special rules in some states in the US for the platforms, handrail, stairs and stuff like this. Safety things are different from state to state and of course they have to follow this but besides this why couldn't they choose the ones we have chosen here? But their market is shrinking and they now have to follow our lines."

As can be seen from these quotations, the main reason for complications was that the Danish headquarters didn't know what happened in the US office and vice versa.

X3 let their offshore locations handle local projects but sent expects and project managers from the Danish

headquarters to assist and facilitate knowledge sharing. The headquarters had also started to offshore development tasks for projects managed from Denmark to China. The US office handled tasks for the US market and rarely interacted in any larger degree with the offices in Denmark or China. When needed, experts and project managers were sent from Denmark to the USA but locals (Americans) were mostly used. For X3 the focus was more on exchange programs and expatriation as sources of knowledge transfer and secondarily on developing procedures and processes.

X4 had only recently started having development in China. They had several project managers, the leader of the subsidiary and experts stationed in China to facilitate knowledge transfer. The difficulties in communication and knowledge sharing of offshoring development to China had been a surprise and X4 counteracted it with increasing procedures and processes. These were developed on a 'learning by doing' basis and were based on the ones used in Denmark but were more detailed and specific. While some of the expats chose to change the procedures and processes in some way to better fit it into the subsidiary's work pattern and culture the procedures and processes were mainly developed and conceived in the Danish headquarters.

The case companies reacted to the difficulties related to communication and knowledge sharing of R&D offshoring by:

X1: having early on developed awareness of the need for explicit knowledge of their development process and where this knowledge resided within the company. They lessened the impact of virtual communication and culture by using codified knowledge in the form of procedures and personified knowledge in the form of expatriates and exchange programs.

X2: employing clear specifications, intense knowledge sharing through documentation and exchange programs, and a serious attempt to transfer the same western organisational culture to all their locations.

X3: a clear separation of tasks (e.g. markets) between the different locations and heavy use of personified knowledge transference. Secondarily to use more processes, procedures and written communication.

X4: codified knowledge and communication and streamlined communication whenever possible.

Clear precise communication was already seen as a key goal.

To summarize, management of offshored R&D encounters difficulties in the form of culture and virtual communication. Culture impacted communication and increased the chance for misunderstandings, rework and quality issues. Virtual communication of information and knowledge sharing across cultures made both knowledge and communication more difficult.

The case companies attempted to counteract this and increase transparency by:

1) Simplifying the development process or product sent abroad for development.
2) Making the process more explicit.

The first was implemented by using fewer and less complex technologies (for example mechanical), employing known technology and development methods or in production by utilizing more manpower and less machinery.

The latter, by attempting to codify as much knowledge as possible, to streamline communication and information and develop more and detailed documentation and procedures. In some case companies to clearly separate tasks and assignments and in this way limit the need for communication and interaction between locations.

However, despite these attempts to counteract difficulties with knowledge and communication structures the case companies still fought with issues mainly related to:

1. Creating transparency in each location and in the interaction between these.
2. Ensuring everyone followed procedures and processes.
3. Ensuring information was understood the same way.

4.3. Relationship between transparency and knowledge transformation

For all the case companies transforming communication and knowledge from verbal and tacit form into a format which could be written down, documented and codified was a key way to archive transparency. The transformation process took place in the headquarters and the documentation was then shared with the subsidiaries.

Interviewees from X2 explained that exploiting their resources as best as possible was a main goal in regard to streamlining and documenting communication.

A manager explained,

"We are saying we want this unit [in India] to be able to support any of the companies out here so we will have the same tools, the same drawing rules and this and that. The drawings sent to U.S., Denmark or somewhere else whether it is product A or product B would look the same. You can imagine we are more than 10 000 people at the company and they all have their special opinion of how things should be. Even internally in Denmark it can be a problem... somebody may want to have their special fingerprint on a given drawing. So, even this we make manuals for [....] the Indians are better at looking into manuals. They are following the manuals where the Danes they are more reluctant. It is [not always] really being followed in Denmark while in India….You can be sure they are following it to the last sentence."

In the case companies, interviewed managers in the subsidiaries often felt the documentation needed adjustment to fit the subsidiary or could be improved upon to make the described process or function more efficient – not just for the subsidiary but for the whole organisation.

A manager from X4 explained it like this,

"Yes, because some of the routines, if everyone has worked with them for a long time it takes a lot to start changing them. But new eyes say this is not a clever way, why do I have to type the same information twice on two different spread sheets and well, maybe you don't."

However, the interviewed managers in the subsidiaries felt there was no way to communicate back to the headquarters about these changes. There were no communication channels, procedures or processes implemented which allowed for this.

All the managers in the subsidiaries also explained that security measures for offshored R&D engineers were much more extreme than for their colleagues back in the Danish headquarters.

In X4 a security measure was for example that the managers had random checks of the employees' computers conducted; something they would never consider doing back at the Danish headquarters. The reason for this was a fear for intellectual property theft and loose laws for this, in particular in China. There was also more quality checks and follow up on work conducted by the engineers in the foreign locations than in the Danish headquarters to be sure the work was up to standards.

5. Theoretical and practical implications

Rasmussen & Wangel (2007) identified three areas important for virtual collaboration;

- Identity.
- Trust.
- Knowledge sharing.

The companies which had few issues with coordination were mainly because they didn't coordinate between subsidiaries and that there were a clear division of tasks and responsibilities between each location.

However, the danger was that the information flow and operation of each location was rather unknown to the headquarters and the other locations. While there frequently existed either a rule or even a procedure for sharing information often it was not followed or implemented. There was an implicit 'us and them' mentality in the approach to communication between the headquarters and the subsidiary.

The focus on status reports and other checkups as well strict security measures for foreign employees also indicates a lack of trust in the offshored R&D employees. This indicates that two of the three key characteristics for successful vertical collaboration - identity and trust - were not present (Rasmussen & Wangel, 2007).

Communication was mainly from the headquarters to the subsidiary and on a vice president to vice president or manager to manager level. Using the SECI knowledge model there was knowledge sharing from individual to individual on the top manager and managerial level but not among the engineers carrying out the work which further created the lack of common identity, trust and transparency. Knowledge sharing from individual to group happened mainly separately in the headquarters and the subsidiary. Exceptions to this were the use of exchange programs and expatriation.

How this was carried out at the subsidiary was largely unknown to the headquarters, further illustrating a lack of transparency. Sharing from group to organisation happened in the headquarters through the development of procedures and processes but managers in the subsidiary found it difficult to do the same. Sharing from the organisation to individual happened mainly through procedures and documented processes; a form of sharing not always successful as will be detailed more in the following.

All the case companies had offshored or outsourced less value adding functions like production and low level designing. The communication strategies they followed with these locations and suppliers could also be the reason why the case companies wanted to implement these procedures which were known to work in other offshore situations. The difficulties the case companies experienced reinforced the perception that these routines should be implemented. However, none of the interviewees questioned whether or not this was an appropriate approach. This learning approach to internationalisation is therefore confirming the findings by Andersen (2008).

The companies all worked towards making as much knowledge as possible explicit as a way to further transparency. However, this was done mainly in the Danish headquarters and without involvement from the subsidiaries. As a result the influence of culture on communication persisted and transparency for the subsidiary was not reached. India and China are high-context (HC) countries; most of the information is either in the physical context or internalised in the person, while very little is in the coded, explicit, transmitted part of the message.

Denmark is a country with low-context (LC) communication, i.e. the mass of the information is vested in the explicit code. It therefore is easier to document and make communication and information explicit in Denmark. However, for a HC country like China and India it can be more difficult as the majority of the information lies in implicit codes. The example from X4 in the previous section shows this when he attempts to adapt and change the procedures and processes he receives from Denmark to better fit the working environment and culture in China.

The horizontal communication process employed in the case companies helped hide the cultural context in communication from the Danish headquarters as the managers they communicated with in the subsidiaries often had learnt the LC communication employed in Denmark.

The less communication and interaction was needed between locations the easier it was to avoid difficulties with transparency in communication and possible complications with the impact of codification as a means to reach transparency. However, transparency was not reached in this manner; the problem areas were merely avoided.

A lack of transparency as viewed from the subsidiaries in the development of the procedures and processes could be a reason why it was difficult for the headquarters to get subsidiaries in countries with HC-communication to follow the same procedures and rules. In other words, the subsidiaries did not take ownership of the processes and procedures as they were not developed with consideration for the cultural and virtual communication needs as viewed from the subsidiaries. There was therefore a resistance in some of the subsidiaries towards adopting these procedures.

Another key issue the findings suggest with transparency through documentation and explicit knowledge is that the overall knowledge of the company could diminish if the tacit knowledge in the subsidiary which can be transformed in the manner detailed in the SECI model does not have the opportunity to do so. The focus on only certain aspects of the SECI model means continuous learning across the organisation won't take place. Furthermore, it may not be possible to codify all information and communication and an attempt to do so

could result in a loss of context which can make the resulting communication and information less valuable.
The research question,
"How does the increasing need for transparent communication structures in global R&D management determine virtual knowledge transformation?" can now be answered.
The investigated Danish multinationals wanted to increase transparency by in the headquarters transforming as much implicit knowledge and verbal communication to written procedures and processes as possible and handed this to their subsidiaries. In other words there was a transformation from implicit knowledge towards explicit knowledge.
The impact of this knowledge transformation was that it increased resistance to adopting new processes and procedures. In addition, not all communication could reach transparency through codification. Transparency was not apparent from the perspective of the subsidiaries by employing this knowledge transformation strategy. Finally transparency through codification does not consider the embedded cultural elements of communication.
To summarize, multinationals offshoring R&D encountered increasing difficulties with global R&D management due to culture and virtual communication. The actions taken by the case companies to counteract this and gain greater transparency was simplification of the product or process or codification of knowledge and streamlining information sharing. These methods to reach transparency meant one-way communication and knowledge sharing; from the headquarters to the subsidiary.
The impact was that knowledge and information residing in the subsidiaries was lost. There was no channel through which to communicate and share knowledge from the subsidiary which didn't fit the reporting structure and procedures implemented from the headquarters. Furthermore, the increased use of procedures and procedures for communication discouraged innovation and new ideas if these did not fit the implemented processes and discouraged unlearning of old routines. Furthermore, the cultural element within communication remained, making it questionable how successful a complete reliance on these transparency methods can be when it involves countries with both HC and LC communication cultures.

6. Recommendations

These findings enable us to suggest that companies should make themselves aware of the potential impact offshoring R&D can have on knowledge and communication. Before anything is moved abroad, the companies need to develop a framework for transparency in their management of offshore R&D activities.
This can be reached achieved through:

Modularity

Headquarters divides R&D into modules or blocks which are each clearly defined and self-contained. This limits the need for communication and knowledge sharing across distances.

Before moving a R&D task abroad, the headquarters needs to consider a number of factors which include (but not limited to):

- The company's history with offshoring.
- Maturity of the task affected by offshoring
- The number of units involved
- How tasks can be separated
- The available codified knowledge
- The cost of transforming needed explicit knowledge
- The possibility of making this knowledge transformation.

Modularity may be easier with simpler and more routine tasks than new and complex tasks.

Collaboration

Headquarters and the subsidiaries develop a communication and knowledge sharing framework which before anything is moved out considers a number of factors which include:

- The company's history with offshoring
- Maturity of the task affected by offshoring
- The number of units involved
- The communication cultures of the units involved
- Virtual as well as horizontal communication with and involvement from engineers on all levels of the subsidiary
- The available codified knowledge
- The cost of transforming needed explicit knowledge
- The possibility of making this knowledge transformation
- The possibility to and cost of transferring implicit knowledge in its original form (e.g. expatriation, exchange programs)
- Advanced communication and knowledge sharing technologies, that enhance mutual transparency

It is suggested that the communication plan is developed in collaboration with the subsidiaries so they experience transparency in the process which will enhance trust and ownership. This could be done using collaborative methods like for example the creation of learning spaces or work space laboratories where managers and employees can perform proactive-creative workshops using for instance search conferences and scenario workshops, design games, interactive planning, participatory SWOT or future creative workshops (Rasmussen, 2008).
Furthermore, the multinationals could create opportunities for networking or peer exchange between subsidiaries and knowledge institutions as a means of combining innovative and already practiced ideas and knowledge (Rasmussen, 2005). This would increase transparency and help build a common identity, trust and improve knowledge sharing; key elements for successful virtual collaboration.
Greater insight into how transparency can be reached in a global R&D management and what tools to use to reach this goal is valuable in order for companies to make informed decisions. It leaves the option of improving efficiency and flow in the R&D process itself, and lessens the chance of costly rework. Offshoring becomes a

learning experience in greater internal understanding as much as a way to meet business targets.
However, this article also shows that the company needs to be aware of the risks embedded in reaching transparency through knowledge transformation. Therefore, in this paper it is suggested that a company implement an offshore strategy in regard to transparency which include several aspects, such as the maturity of the R&D task, the number of units involved in communication and the available codified knowledge and likely cost and option to transform additional needed knowledge.
In several of the case companies the managers in the subsidiaries had ideas on how knowledge and information could be shared and transparency could be improved. The case companies can use these results to have managers from both the headquarters and the subsidiary meet and conduct a workshop. Here they could analyse which aspects each of them believe course difficulties with communication and knowledge sharing at the headquarters, at the subsidiary and in the interaction between these and develop new ideas and plans together on how to increase transparency. By developing a new communication and knowledge sharing plan in collaboration the risk and responsibility is shared. Furthermore, transparency is reached within the decision process itself.

7. Conclusions and further research

This paper investigated the connection between transparency and knowledge transformation in R&D offshoring using case studies involving four multinational corporations. Data was gathered through 29 in-depth semi-structured interviews with managers at headquarters and at the subsidiary.
The research question was: "How does increasing R&D offshoring impact management of communication structures and knowledge sharing?"
In the investigated Danish multinationals communication with the subsidiary was horizontal at the managerial level, but not at the engineering level. Communication was mainly from the headquarters to the subsidiary concerning new assignments and status reports on current work. Cross-cultural virtual communication had created greater difficulties with communication which had resulted in misunderstandings, rework and delays. To counteract this, the case companies had chosen to make the work processes more explicit or the product or process simpler. To achieve this, headquarters would transform as much implicit knowledge and verbal communication to written procedures and processes as possible and handed this to their subsidiaries. In other words there was a transformation from implicit knowledge towards explicit knowledge.
Difficulties in communication remained as transparency was not reached inside the subsidiaries and communication inside the subsidiary was not clear to the headquarters. Furthermore, culture remained a key issue as certain cultures rely more on context and internalisation in the person than the explicit code of communication than others. As a consequence embedded cultural elements of communication were not considered by this attempt at reaching transparency. The impact of this knowledge transformation was that it increased resistance to unlearning of old routines and adopting new processes and procedures. In addition, not all communication could reach transparency through codification. Finally, transparency was not apparent from the perspective of the subsidiaries by employing this knowledge transformation strategy.
This study shows the importance of understanding the connection between knowledge transformation and the need for transparency in R&D processes. From a financial, managerial and technical perspective an increased understanding of this connection from the onset of R&D offshoring could potentially prevent costly misunderstandings and rework.
Further research is needed to understand in what situations transparency through codification are desirable, what type of communication can be the codified, the influence of culture on communication and how a two-way communication between the headquarters and the subsidiary in the codification process would influence the success rate.

Acknowledgements
The authors would like to thank Whitestone Associates for financial support, and the case companies for their time and valuable insight.

8. References

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